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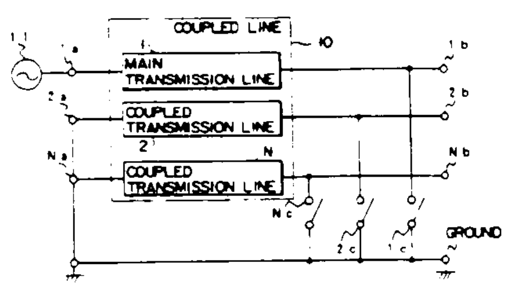
WIDE BAND FREQUENCY ALLOTMENT TYPE SIGNAL SELECTION DEVICE UTILIZING ELECTROMAGNETIC COUPLING.

A signal selection device which uses distributed coupling lines and has less distortion over a wide range from a low frequency to a high frequency. Ends (2a-Na) of respective coupling transmission lines (2-N) are connected with the earth. The transmission lines (2-N) are coupled to a main transmission line (1) through an electric or magnetic field or through the both. Therefore, by the signal fed from a signal source (11) and inputted into a common end (1a), signals are induced in the respective coupling transmission lines (2-N). When desired one of conduction means (2c-Nc) is turned off (e.g., means 2c is made off) and the other means are all turned on (e.g., the means other than 2c are made on), at the signal selection end (e.g., 2b) corresponding to the conduction means which is off, signal appears, but at the other signal selection ends no signal appears. Since no nonlinear device exists in signal paths, no signal distortion is generated, and since no DC blocking capacitor connected in series with the main transmission line exists, even a signal in a DC band is transmissible. Therefore, this device is applicable to such apparatuses in various fields as a wide band spectrum analyzer and a wide band signal generator.



F I G. 2

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③ A signal having a DC band cannot be transmitted because the DC blocking capacitors (C1 to C3) are inserted in series in a path through which a signal passes.

Summary of the Invention

It is, therefore, an object of the present invention to provide a wideband frequency distributed signal selector capable of selecting a signal in a wideband including a DC band to a microwave band without any signal distortion.

According one aspect of the present invention, there is provided a signal selector comprising:

a main transmission line having one common terminal;

one or a plurality of coupled transmission lines having at least one signal selecting terminal and coupled to the main transmission line by an electric field, a magnetic field, or both the electric and magnetic fields; and

a plurality of conducting means which are respectively connected between the signal selecting terminal and ground or between ground and the signal selecting terminal and between ground and the other end of the main transmission line and can be selectively ON/OFF-operated.

That is, according to the present invention, in order to provide a signal selector capable of solving the problems of the prior art, the distributed coupled line constituted by the main transmission line and one or the plurality of coupled transmission lines coupled to the main transmission line by the electric field, the magnetic field, or both the electric and magnetic fields is arranged, and the conducting means which can be selectively ON/OFF-operated is arranged between one end of a desired transmission line and ground.

With the above arrangement, in a signal selector using both the electric field and the magnetic field, a signal to be selectively transmitted is input to the common terminal. One end of each of the coupled transmission lines is grounded. Since the coupled transmission lines are coupled to the main transmission line by the electric field, the magnetic field, or both the electric and magnetic fields, the signal input to the common end is induced to each of the coupled transmission lines.

In the above state, when only one of the plurality conducting means corresponding to a signal selecting terminal to which a signal is to be transmitted is turned off, and the remaining conducting means are turned on, the signal can be transmitted to a desired signal selecting terminal.

That is, according to the present invention, an input signal is branched into a main transmission line and a coupled transmission line in accordance with frequency bands in a distributed coupled line obtained by electromagnetic coupling, and the branched signals are selected by a plurality of conducting means arranged between each line and ground. Therefore, when a coupled transmission line is selected, a signal in a highfrequency band is output. When the main transmission line is selected, a signal ranging from a DC band to a high-frequency band is output. With the above arrangement, a wideband frequency distributed signal selector can be realized.

Note that, when the signal selector is used such that its input and output are reversed to each other, it can also be used as a signal synthesizer.

Brief Description of the Drawings

Fig. 1 is a view showing an arrangement of one embodiment of a signal selector according to the present invention;

Fig. 2 is a view showing another arrangement of the signal selector of the present invention to explain the function of Fig. 1;

Fig. 3 is a view showing an arrangement of a detailed example of a plurality of conducting means in Fig. 1;

Fig. 4 is a view showing an arrangement of a main part of another detailed example of the conducting means in Fig. 1;

Fig. 5 is a view showing an application example of a signal selector according to the present invention;

Fig. 6 is a view showing another application example of the signal selector according to the present invention;

Fig. 7 is a view showing an arrangement of a signal selector constituted by transmission lines using a magnetically coupled transformer;

Fig. 8 is a view showing an arrangement of an embodiment using electric coupling;

Fig. 9 is a view for explaining an odd-mode characteristic impedance of a coupled line;

Fig. 10 is a view for explaining an even-mode characteristic impedance of the coupled line;

Figs. 11A and 11B are a graph showing transmission characteristics and a view showing a conditional circuit of the transmission characteristics, respectively, in which

Fig. 11A is a graph showing transmission characteristics obtained by the simulation of the first application example and

Fig. 11B is a view showing the conditions of the first application example;

Figs. 12A and 12B are a graph showing transmission characteristics and a view showing a conditional circuit of the transmission characteristics, respectively, in which

Fig. 12A is a graph showing transmission characteristics obtained by the simulation of the sec-

turned on a signal appears at the signal selecting terminal 1b, but no signal appears at the signal selecting terminals 2b to Nb.

In addition, when desired one of the conducting means 2c to Nc is turned off (e.g., the means 2c is turned off), and all the remaining conducting means are turned on (e.g., the conducting means other than the means 2c are turned on), a signal appears at the signal selecting terminal (e.g., 2b) corresponding to the conducting means (e.g., 2c) which is turned off, but no signal appears at the remaining signal selecting terminals.

That is, when only a conducting means corresponding to a signal selecting terminal to which a signal is to be transmitted is turned off, and the remaining conducting means are turned on, the signal can be transmitted to a desired signal selecting terminal.

(Detailed Description of Conducting Means)

Switches, relays, and the like each having a mechanical contact can be used as the conducting means 1c to Nc in Fig. 2 when switching repetition does not pose any problem on service life. However, when high-speed repetitive switching operations must be performed, a conducting means using a semiconductor element is effectively used. The conducting means using the semiconductor element will be described below with reference to Figs. 3 and 4.

In Fig. 3, each of capacitors C1 to CN and each of diodes (e.g., PIN diodes) D1 to DN are connected in series between ground and a corresponding one of the signal selecting terminals 1b to Nb, and one end of each of resistors R1 to RN is connected a corresponding one of connection points between the capacitors and the diodes. The other end of each of the resistors is connected to a corresponding one of control terminals 1d to Nd.

In the conducting means arranged as described above, when a negative bias voltage is applied to the control terminal 1d, and a positive bias voltage is applied to the control terminals 2d to Nd, the diode D1 is negatively biased to be turned off. That is, an open state is set between the signal selecting end 1b and ground, and the signal supplied to the common end 1a appears at the signal selecting end 1b.

The diodes D2 to DN are positively biased to be turned on. That is, the signal selecting terminals 2b to Nb are short-circuited to ground, and no signal appears at the signal selecting terminals 2b to Nb.

As described above, a negative bias voltage is applied to the control terminal of a conducting means corresponding to a signal selecting terminal from which a signal is to be extracted, and a positive bias voltage is applied to the control terminals of conducting means corresponding to the remaining signal selecting terminals.

The capacitors C1 to CN are arranged to block the DC bias voltage so as to prevent the loads or signal sources connected to the common terminal 1a or the signal selecting terminals 1b to Nb from the influence of the DC bias voltage for ON/OFF-controlling the diodes. In addition, the resistors R1 to RN are arranged to keep a high impedance between a path through which a signal passes and a bias voltage source and to isolate the path from the bias voltage source.

Fig. 4 is a view showing an arrangement of an example of the conducting means 1c using a transistor. In Fig. 4, although only the main transmission line 1 and the conducting means 1c corresponding thereto are extracted and simplified, each of the remaining coupled transmission lines 2 to N has the same arrangement as that of the main transmission line 1.

The collector, emitter, and base of a transistor T are connected to the signal selecting terminal 1b, ground, and the control terminal 1d, respectively. When a positive bias voltage is applied to the control terminal 1d, the signal selecting terminal 1b is short-circuited to ground, and no signal appears at the signal selecting terminal 1b. In addition, when a negative bias voltage is applied to the control terminal 1d, the signal selecting terminal 1b is disconnected from ground, and a signal appears at the signal selecting terminal 1b.

When the transistor T is operated in a saturation state, since the collector-emitter path exhibits a pure resistance behavior, the transistor T can be used as a switch regardless of a DC closed path. For this reason, it can be properly selected in a design to interpose a capacitor between the signal selecting terminal 1b and the collector of the transistor T.

As described above, since no nonlinear element such as a diode is interposed in the main transmission path 1 and the coupled transmission lines 2 to N, a selectively transmitted signal has no distortion.

In addition, since a DC blocking capacitor is not interposed in the main transmission line 1, a signal having a DC band can be transmitted between the common end 1a and the signal selecting terminal 1b. As a conducting means used in this case, the conducting means using the transistor T shown in Fig. 4 is effectively used.

Since the main transmission line 1 is coupled to each of the coupled transmission lines 2 to N by an electric field, a magnetic field, or both the electric and magnetic fields, a signal having a DC band cannot be transmitted to the coupled transmission lines 2 to N.

in the longitudinal direction of the transmission lines, and Fig. 16B is a sectional view along a line parallel to the axis. A main transmission line 1 is arranged on one surface of a support member 8 consisting of an insulator, and a coupled transmission line 2 is arranged on the other surface. One terminal 2a of the coupled transmission line 2 opposite to a common terminal 1a of the main transmission line 1 is connected to a case 9 serving as ground. A switch 1c is arranged between ground and a signal selecting terminal 1b serving as the other end of the transmission line 1, and a switch 2c is arranged between ground and a signal selecting terminal 2b serving as the other end of the transmission line 2.

Fig. 17 shows an arrangement of a coupled line having a tapered main transmission line and a tapered coupled transmission line. Other constituent elements and function of the coupled line are the same as described above. The arrangement in Fig. 17 is especially suitable for the coupled line shown in Figs. 16A and 16B.

Figs. 18A to 18D show the signal selector shown in Figs. 16A and 16B in detail. Fig. 18A is a plan view showing a signal selector in which SMA connectors are projected from a shield case 9 in a Y shape as a common terminal 1a and signal selecting terminals 1b and 2b, respectively, when the upper lid of the signal selector is removed. Inside the case 9, a flat type main transmission line 1 indicated by broken lines in Fig. 18A and a taper type coupled transmission line 2 are formed on the upper and lower surfaces of a support member 8 as strip lines (referring to the sectional view in Fig. 18D), respectively. As shown in Fig. 18B as an enlarged view of a portion surrounded by a circle A in Fig. 18A, capacitors C1 and C2, PIN diodes D1 and D2, and resistors R1 and R2 which are respectively connected between ground and the lines 1 and 2 are incorporated in the case 9 (referring to the wiring diagram in Fig. 18E). Fig. 18C is a side view. In Fig. 18C, a control bias terminal 1d connected to one end of the resistor R1 is projected from one side surface of the case 9, and the control bias terminal 2d connected to one end of the resistor R2 is projected from one side surface of the case 9.

A deformation bismaleimidetriazine resin (maximum width: 7 mm; thickness: 0.74 mm; and specific dielectric constant: 3.8) containing a glass fiber material is used as the support member 8. The main transmission line 1 is a flat type transmission line having a width of 2 mm and a length of 25 mm, and the coupled transmission line 2 is a taper type transmission line having a maximum width of 4 mm, a minimum width of 2 mm, and a length of 25 mm. Each of the capacitors C1 and C2 has a capacitance of 2,000 pF, and each of the resistors R1 and R2 has a resistance of 1 kΩ.

Figs. 19A and 19B show the actually measured characteristics of a signal selector arranged under the above conditions and a conditional circuit under the conditions, respectively. More specifically, excellent transmission characteristics which support the results of the above simulation shown in Figs. 11A and 11B can be obtained.

(Another Example Using Magnetic Coupling)

Another example using magnetic coupling is obtained as follows. For example, a bifilar winding delay line disclosed in a research and application report of Telecommunication Laboratory of Japan, Vol. 17, No. 12 (published in 1968) pp. 159 to 174 (basic study related to a wideband line type transformer) and (especially shown in Fig. 5 of p. 164) is used as an actual transmission line such that two insulating lines are twisted, and the stranded wire is wound around a magnetic member. According to this technique, when a large number of insulating lines are twisted, and stranded wires are wound around a magnetic member, a required multi-wire line can be obtained.

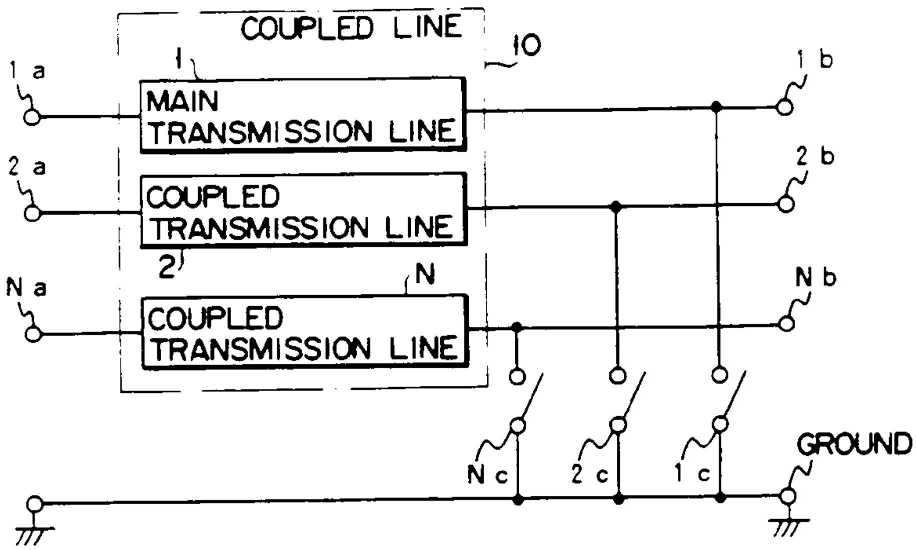
A technique disclosed in "PROCEEDINGS OF THEIRE" 1959, August, pp. 1,337 to 1,342 (Some Broad-Band Transformers) can be used for a bifilar winding.

(Other Application Examples)

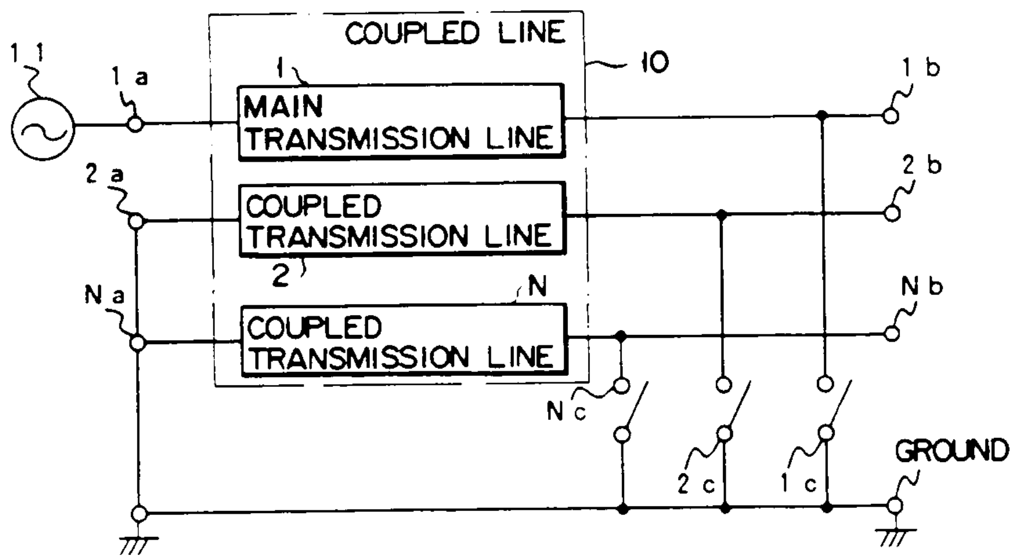
In the application example in Fig. 2, in general, one switch is turned off, and all the remaining switches are turned on, thereby obtaining a signal from a signal selecting terminal corresponding to the OFF switch. However, an application example in which all switches are turned on (no signal is supplied to all signal selecting ends) or an application example in which a plurality of switches are turned off (a signal is supplied to a plurality of signal selecting terminals at the same time: signal distribution) may be used. In this case, although faults such as a signal loss and impedance matching are caused, when the faults do not adversely affect a peripheral circuit, the above application examples can be used.

(Compensation of Capacitance of Switch)

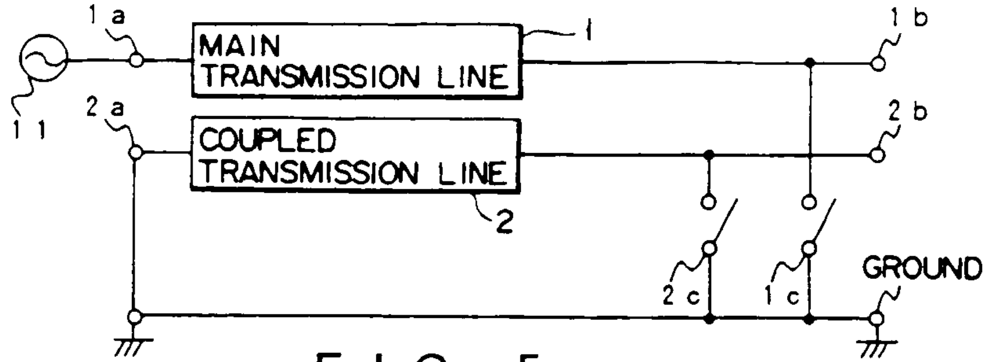
In each of the above embodiments, when a signal selector is used in a frequency range in which the stray capacitances (Cs) of switches are not negligible, as shown in Fig. 20, frequency characteristics can be improved by adding inductors L_{a1}, L_{b1}, L_{a2}, and L_{b2}. Note that the capacitances can be compensated by adding only the inductors L_{a1} and L_{b1} or the inductors L_{a2} and L_{b2}.


COUPLED LINE
10
1
1a
MAIN
TRANSMISSION LINE
1b
2a
COUPLED
TRANSMISSION LINE
2b
2
N
Na
COUPLED
TRANSMISSION LINE
Nb
Nc
2c
1c
GROUND

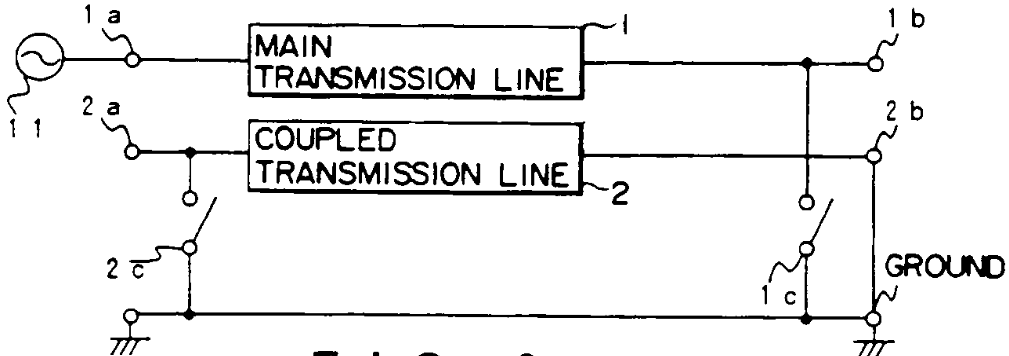
F I G. 1


COUPLED LINE
10
11
1a
1
MAIN
TRANSMISSION LINE
1b
2a
COUPLED
TRANSMISSION LINE
2b
2
N
Na
COUPLED
TRANSMISSION LINE
Nb
Nc
2c
1c
GROUND

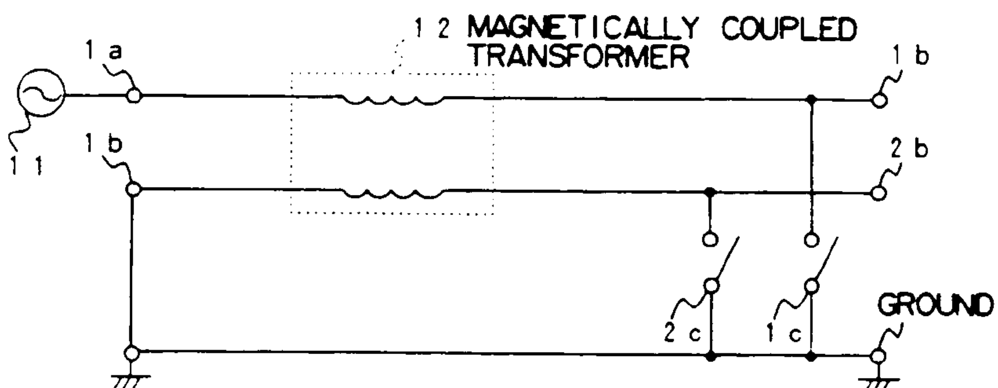
F I G. 2



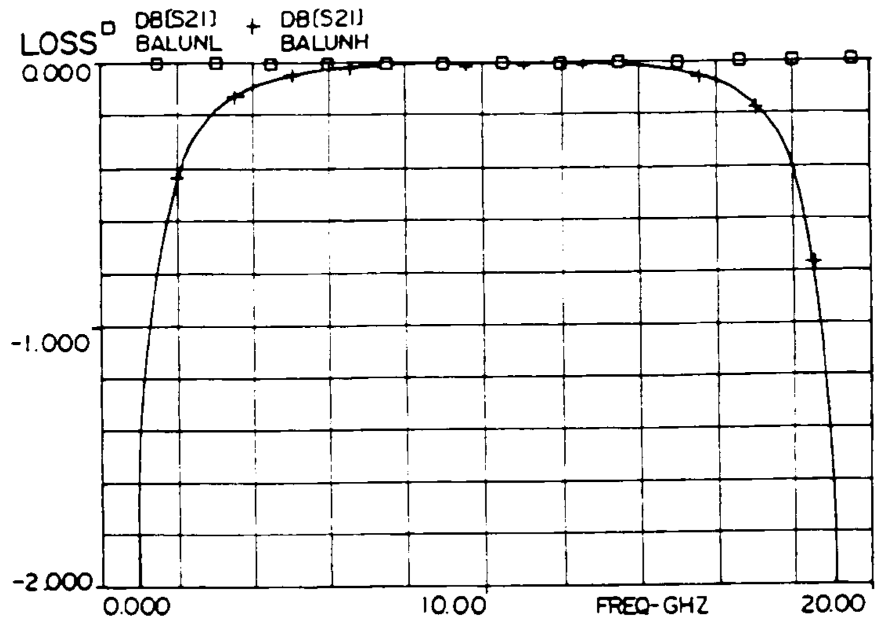
F I G. 5



F I G. 6



F I G. 7



Zoo = 25Ω Zoe = 1,000Ω θ = 90deg (AT 10 GHz)

□———□ ①←→② TRANSMISSION CHARACTERISTICS (SW2 : ON)

+———+ ①←→③ TRANSMISSION CHARACTERISTICS (SW1 : ON)

FIG. 11A

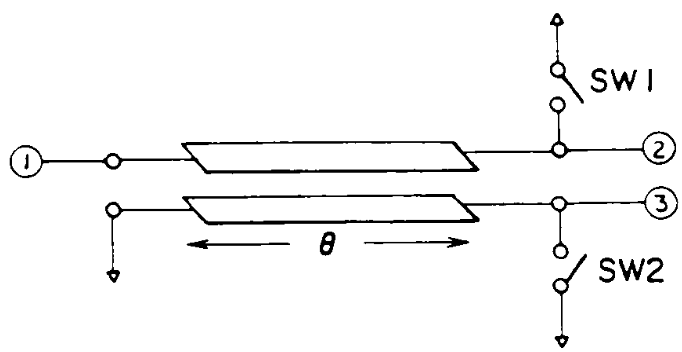


FIG. 11B

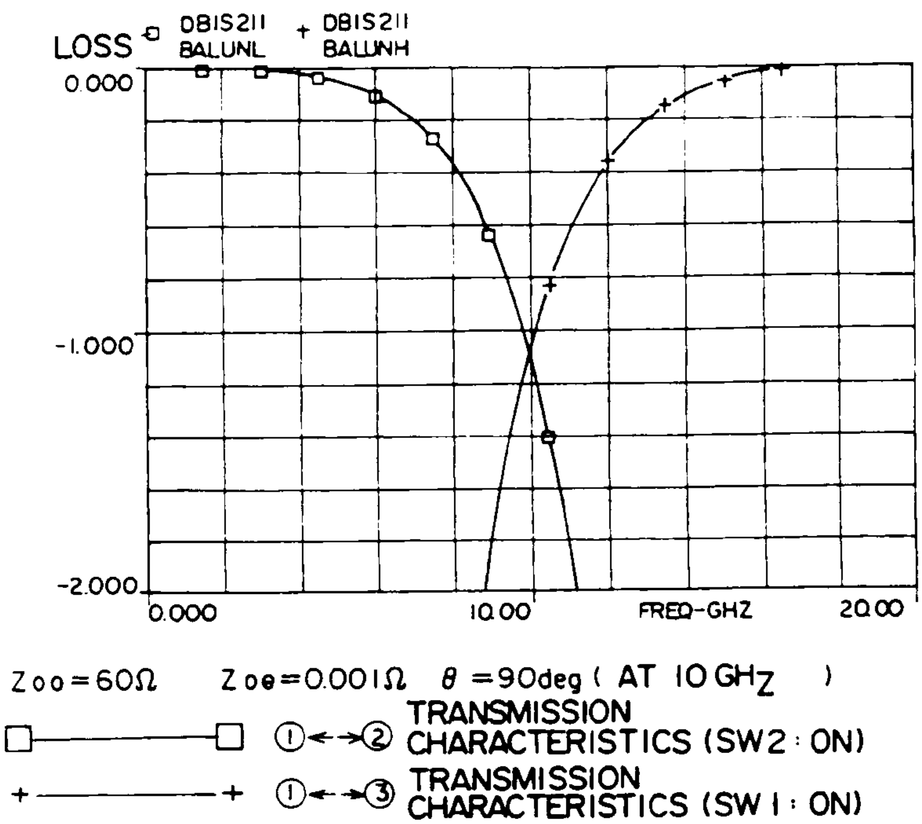


FIG. 13A

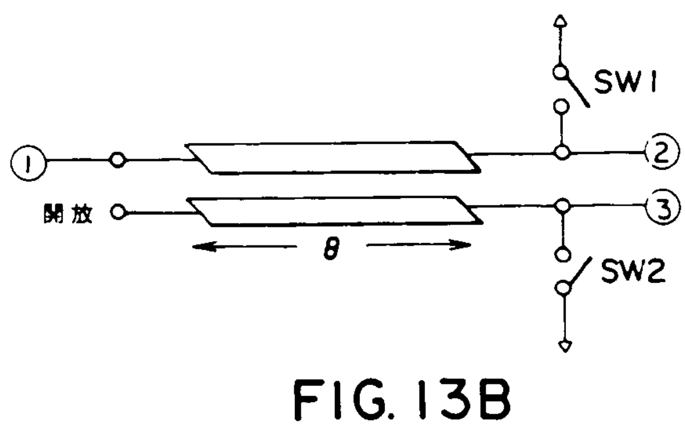


FIG. 13B

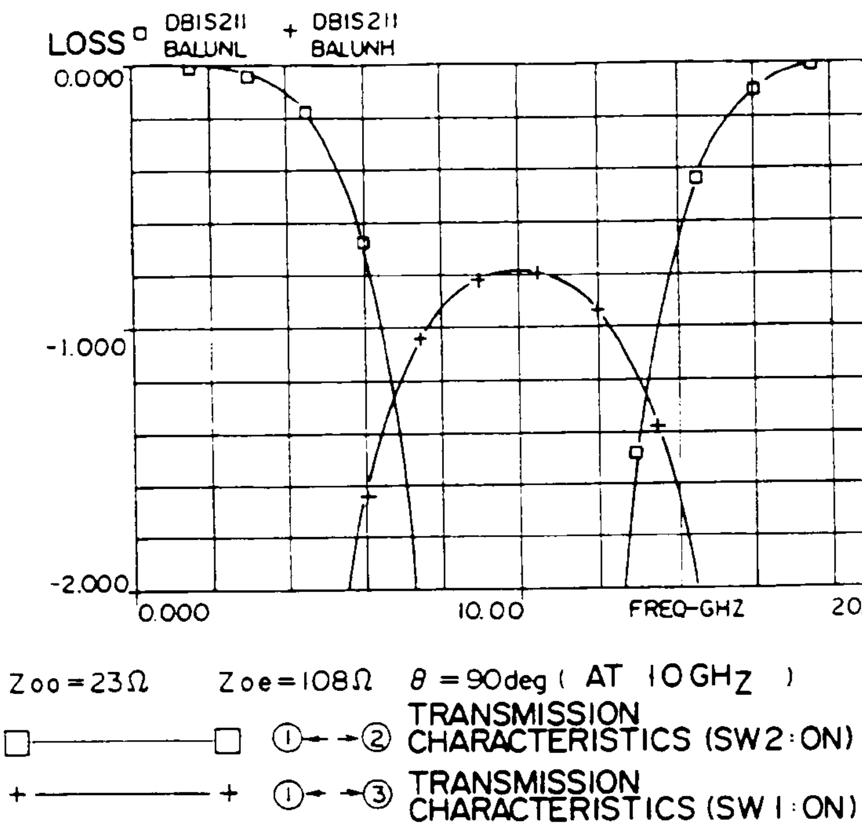


FIG. 15A

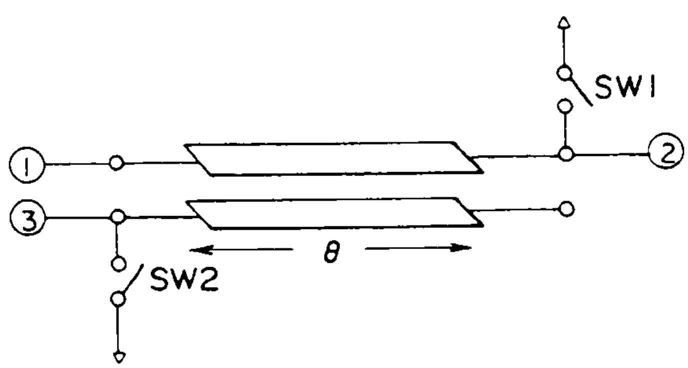


FIG. 15B

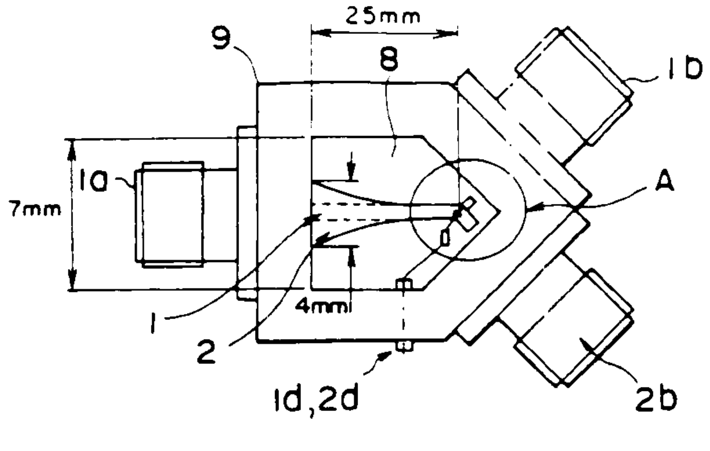


FIG. 18A

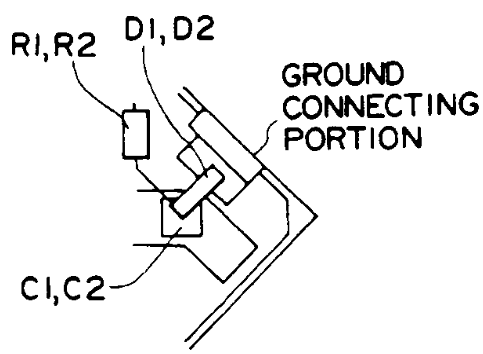


FIG. 18B

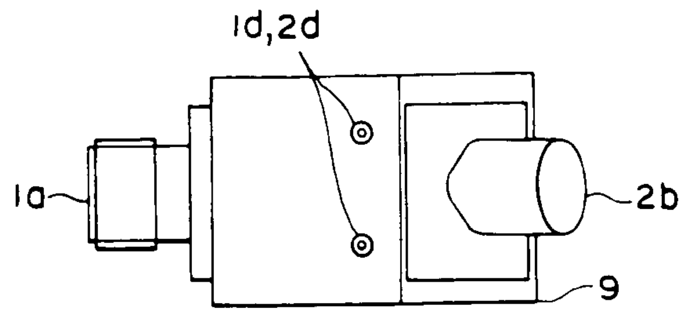


FIG. 18C

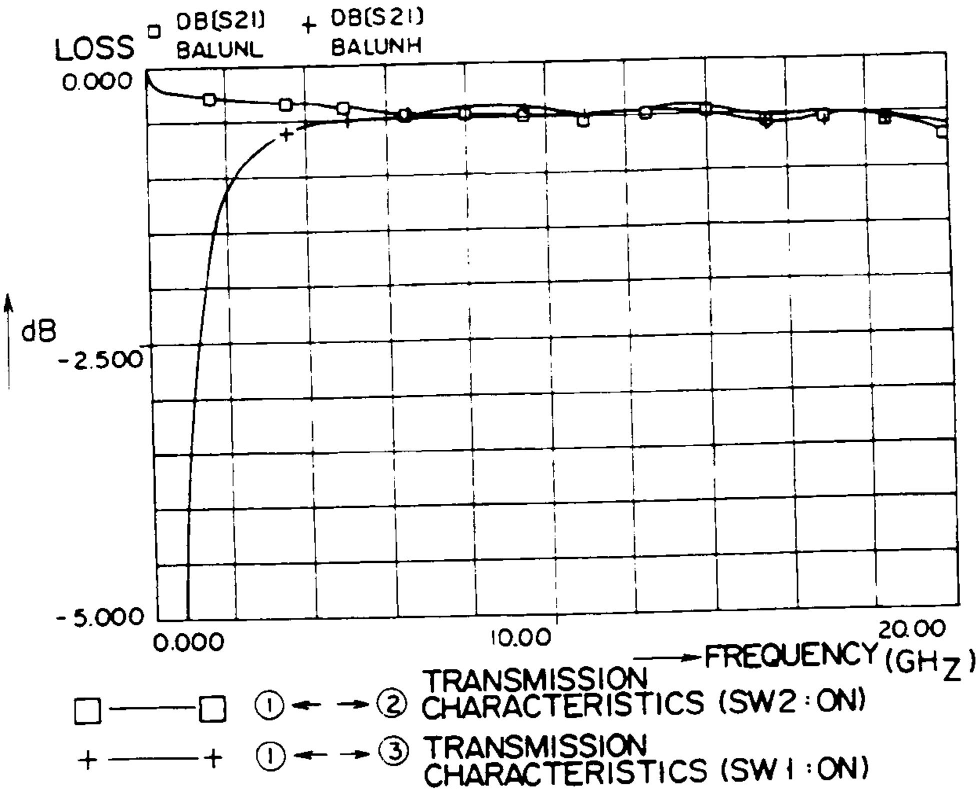


FIG. 19A

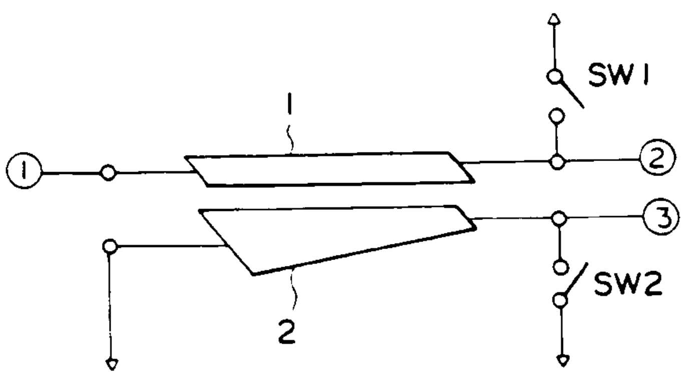


FIG. 19B

INTERNATIONAL SEARCH REPORT

International Application No PCT/JP92/00350

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl[5] H01P1/15, 5/12

II. FIELDS SEARCHED

Minimum Documentation Searched

Classification System	Classification Symbols
IPC	H01P1/15, 5/12, 5/18

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched

Jitsuyo Shinan Koho	1926 - 1991
Kokai Jitsuyo Shinan Koho	1971 - 1991

III. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
Y	SU, A, 231643 (KARLIN, E. V. & GATILOV, V. G.), May 7, 1969 (07. 05. 69), (Family: none)	1-10
Y	JP, A, 62-13101 (Mitsubishi Electric Corp.), January 21, 1987 (21. 01. 87), Line 5, lower left column to line 4, lower right column, page 1, Fig. 1 (Family: none)	3, 4
Y	JP, B1, 35-1862 (Kenzo Nagai, Risaburo Sato), March 8, 1960 (08. 03. 60), Lines 8 to 12, left column, page 2, Figs. 1 and Fig. 4(a)-(d) (Family: none)	7, 8
A	M. Matsunaga et al., "An X-Band 12W GaAs Monolithic Transmit - Receive Switch", The Transactions of the IEICE,	1

* Special categories of cited documents:
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
June 2, 1992 (02. 06. 92)	June 23, 1992 (23. 06. 92)
International Searching Authority	**Signature of Authorized Officer**
Japanese Patent Office	

Form PCT/ISA/210 (second sheet) (January 1985)